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Farm Ponds

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The Construction and Management of FARM PONDS IN ONTARIO

by

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INTRODUCTION

Ponds can serve a variety of utilitarian purposes and enhance the beauty and value of rural areas. The more important uses for farm ponds are as follows:

household and livestock water supply

fire protection for farm buildings

irrigation and spray water supply

fish production

recreation

wildlife habitat

The traditional sources of water on the farm have been wells, springs and streams. The supply of water from these sources in recent years has frequently been inadequate. Modern water supply and plumbing facilities in rural homes have created greatly increased water demands. Water for cooling and cleaning purposes, in order to provide better quality produce for the market, has been an additional factor in increasing water needs. Larger holdings of cattle, hogs and poultry on many farms have placed an additional drain on water supplies. The control of disease, insects and weeds by spraying necessitates a reliable supply of water.

Irrigation of tobacco, fruits and vegetables has been a major factor in obtaining consistently high yields of top quality produce. A half-acre farm garden will require as much water for irrigation during a week as is used in the modern farm household during a month. Quantities of water required for irrigation are large, even though the period of use is seasonal and relatively short.

The development of farm ponds for recreation and fish production offers many opportunities for private use and may form the basis of a commercial enterprise. While ponds have been used for these purposes for many years, the increasing demand for waters capable of providing fishing and other forms of recreation has greatly stimulated the interest in farm ponds. Good fish ponds are an asset to any farm and can be relied upon as a source of water to meet the many domestic, agricultural and recreational needs of the farm family. Conversely, with foresight a pond may be built for a specific agricultural use, such as irrigation, but may be suitable for recreation or fish production. In many instances, properly designed ponds may be multipurpose, serving several needs simultaneously.

Certain statutes and regulations pertain to the construction of ponds and the taking of water by diversion and storage. The concluding section of this publication, on Legal Aspects, provides guidance in this matter.

WATER SOURCES FOR PONDS

The waters of the earth are continuously in circulation. This circulation, called the hydrologic cycle, is illustrated in Figure 1. The precipitation (mainly rain and snow) that falls on the earth's surface is disposed of in a number of ways. A certain portion is returned directly to the atmosphere by evaporation from leaf surfaces and the soil. The larger portion is absorbed by the soil to be used at a later date by the plants and returned to the atmosphere.

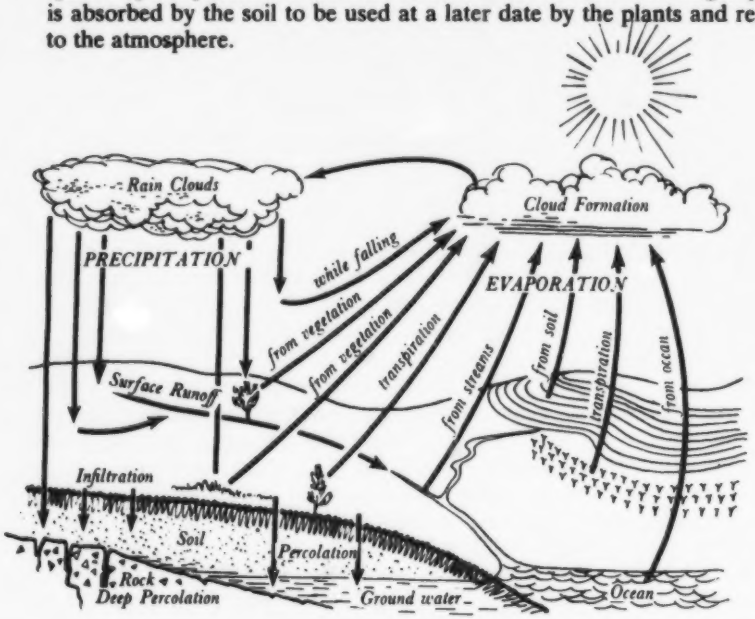

FIGURE 1.
The hydrologic cycle

Shallow and deep groundwater aquifers are recharged by the deep percolation of the excess water absorbed into the soil surface. Groundwater may appear in the form of springs, seeps, or streams.

During high rates of rainfall, or when the ground is frozen, a portion of the rain or snowmelt water flows directly off the surface of the ground into small and large streams.

Under natural conditions, surface and underground water which finds its way to streams is eventually returned to the atmosphere by evaporation from streams, lakes, or the ocean into which it flows.

The cycle is completed by the formation of precipitation and return of moisture to the land and water surfaces of the earth.

Man-made water projects, including the construction of ponds, short-circuit the natural circulation pattern of the waters of the earth. Water is collected at times of surplus for use during periods of low rainfall or high demands. The pattern of the hydrologic cycle in a particular area will determine the most suitable water source and type of pond.

Springs and groundwater. Where groundwater exists at a shallow depth, a large hole excavated into the saturated sand or gravel will provide a type of storage readily replenished by inflow from the water-bearing strata in the region surrounding the pond. Such ponds are similar to an oversized dug well. This type of pond is common in the sand plains of the tobacco belt of Ontario. There are many regions where low-lying depressions remain moist for a large part of the year, therefore excavation to tap the shallow groundwater is a worthwhile consideration. Wet sidehill seepage areas also may be excavated to expose a good spring source of water.

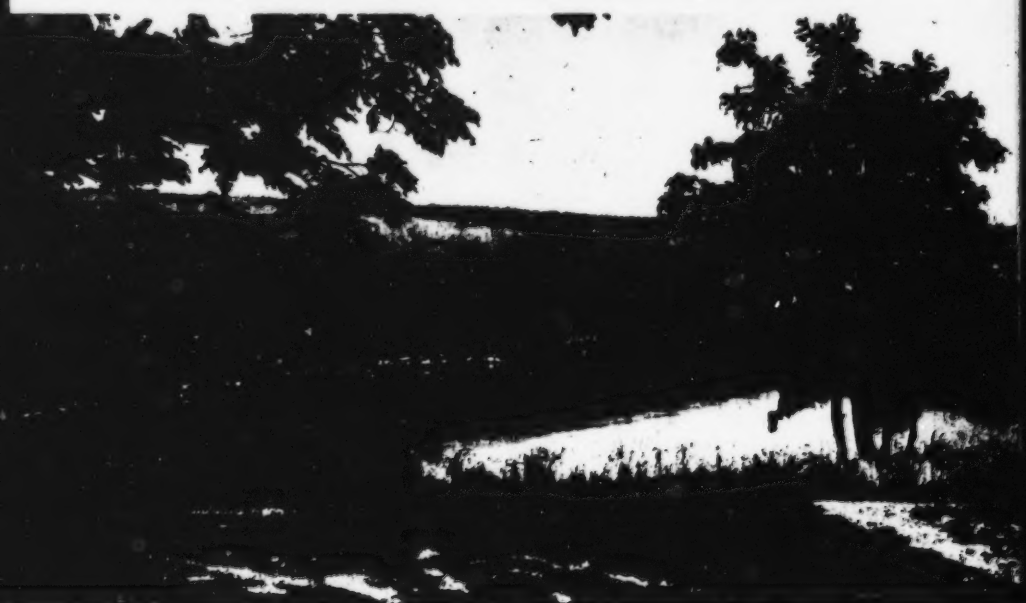

FIGURE 2.
Hillside pond. Water source may be surface runoff or groundwater seepage.

Surface runoff. The surface runoff from small drainage areas will prove to be the best water source for ponds in gently rolling or nearly level clay loam or clay soil regions. In most parts of Ontario surface runoff can be depended upon only during the winter and spring period. The water from melting snow or rain will provide appreciable volumes of runoff from pastureland or cultivated areas. Summer or fall rains on such areas result in only small volumes of surface runoff water.

FIGURE 3.
Dugout pond. Water source is surface runoff or groundwater. Suitable for nearly level area.

Streams. Permanently flowing streams and springs provide a reliable water source for ponds. If the drainage area is small and flood flows are unlikely to occur, the pond may be constructed directly in the channel of

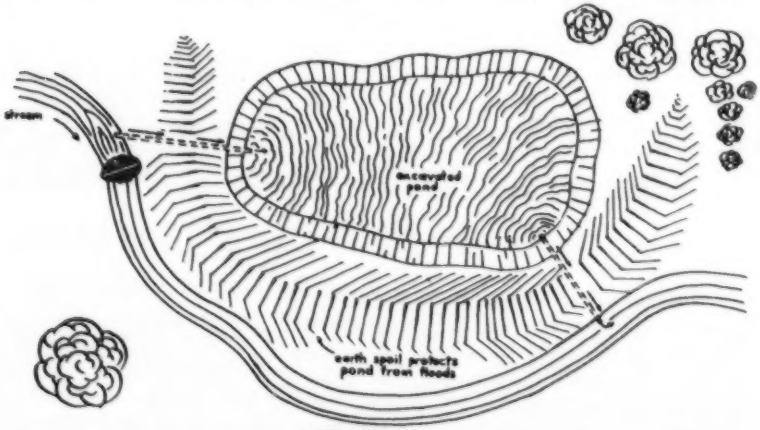

FIGURE 4.
Bypass pond. Excavation in the flood plain eliminates costly construction.

the stream or spring. However, many streams have rather high flood flows, making construction very costly. An alternative in such cases is to excavate a storage reservoir in the flood plain adjacent to the stream.

Bypass ponds permit a portion of the water flowing in the stream to be diverted or bypassed through the pond, while the remainder of the flow occupies the stream valley or the remainder of the flood plains. With a continuous supply of water from streams or springs, the temperature and quality of the water can be regulated for fish production.

Another type of off-stream storage is that which may be located on high ground and filled by pumping from a stream or spring. Gravity flow to watering troughs may thus be arranged.

SELECTION OF POND SITE

Several important points must be kept in mind when selecting the site or deciding upon the feasibility of pond construction. Seldom will all conditions be ideal. However, this should not deter one from investigating the possibilities and obtaining technical advice.

Storage Types

The nature of the water source and topography will govern the construction techniques to be adopted.

Excavated ponds are most adaptable to relatively flat areas and storage is provided entirely below the natural ground surface. The water source may be either surface runoff or local groundwater at shallow depths. Such ponds excavated in flood plains may be filled from the flow of springs or streams.

Impounding ponds consist of a dam or bank of earth constructed across a valley or depression in such a way that storage is primarily above the natural ground level, and is contained by the banks of the drainage channel and the artificial embankment. In practice, it is possible to provide for additional storage by removing soil from the reservoir site for use in construction of the dam. On gently sloping areas without well defined drainage channels, or on off-stream bypass or pump-filled off-stream ponds, water may be economically retained by combining excavation and above-ground impoundment.

Soil Conditions

The soil is probably the most important single factor in determining the suitability of a site and the design of a pond. Coarse soils of sand and gravel are highly permeable to water. When groundwater occurs at a shallow depth in such soils it is an advantage, since rapid flow to an excavated pond will result during and after periods of water withdrawal. However, in

the case of excavated or impounding reservoirs constructed in dry sand or gravel, the losses by seepage will be excessive.

Frequently, sites for reservoirs occur on water courses underlain by sand or gravel with a shallow water table. When proper precautions are taken in the construction of the dam, such sites may be quite satisfactory. Boring test holes with a hand auger or digging test pits should be part of every site investigation. At least four locations should be sampled to a depth of six feet or more on the proposed sites of impounding reservoirs over the dam and pond site, to provide information on the suitability of the soil at the pond site.

On the proposed site for an excavated reservoir, sampling should be carried out to a depth of at least two feet beyond the proposed depth of excavation. Typical samples of the soil should be retained, with notes on their depth of occurrence, so that further laboratory tests and opinions of specialists may be obtained in doubtful cases.

Topography

Land slopes and the drainage pattern will govern the type of pond that can be constructed. As previously pointed out, the excavated pond may be constructed on relatively flat or gently rolling clay loam areas. The only real limitation is the provision of sufficient drainage area to fill the pond.

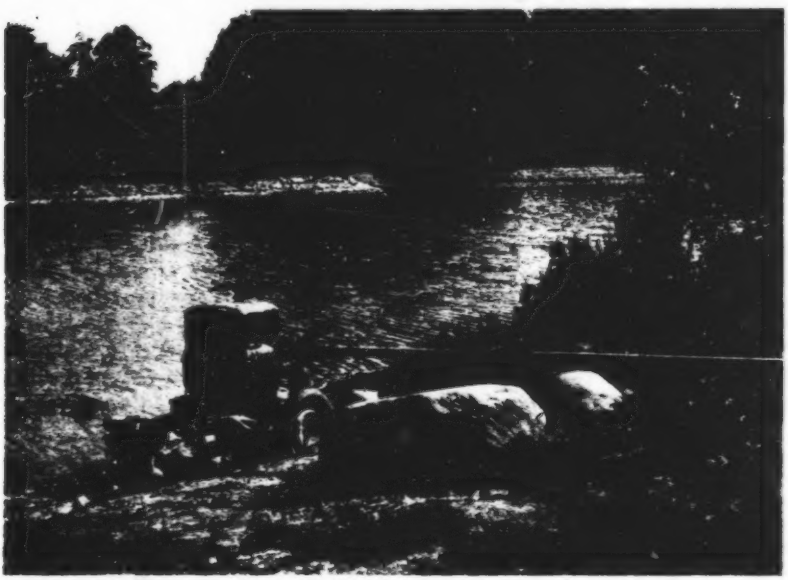

FIGURE 5.
Irrigation pond. Large quantities of water are required, but uses other than irrigation may be served.

The impounding type of reservoir is suited to a narrow valley or draw with a gentle grade in the bed of the channel. Where the channel grade is steep, the volume of storage will be small in relation to the size of the dam. On the other hand, if the grade in the channel is nearly level at the margins of the proposed reservoir, an excessive area of shallow pond water will occur. Weed growth will become a major problem at the pond edges unless deepening by excavation is carried out. Choosing a narrow point in the valley for the actual dam site will result in savings in the cost of earth movement.

Proposed Uses

For most beneficial use, ponds should be located at or near the point where the water is required. Ponds for livestock water supply should be located close to the barns, or centrally within grazing areas. Water for fire protection should be stored near the farm buildings and be accessible to fire fighting equipment. Location of the irrigation pond within the field or orchard will reduce costs for pipe and other equipment.

FIGURE 6.
Multipurpose pond. Many purposes such as livestock watering, recreation, fishing and fire protection may be served.

Recreational ponds, or those constructed for fish and/or wildlife, should be built to take advantage of natural surroundings. Wasteland may be beautified or made more productive by the construction of a pond within such areas.

With sound planning in advance of construction, many ponds may be so designed and strategically located on the farm to serve two or more purposes, i.e., become multipurpose ponds.

Storage Requirements

The pond site selected should provide sufficient storage to meet the projected needs and uses. There will be certain unavoidable losses due to seepage and evaporation. Seepage losses can be minimized by careful selection of site with respect to soil. Evaporation losses will be in the order of one and one-half to two feet of water depth per year. Practical means for controlling evaporation are not yet available. Fortunately, in this province the rain and snow on the pond surface are more than sufficient to replace the evaporation losses.

Assuming average water losses, the following storage requirements are suggested for ponds filled annually by surface runoff only:

1. Livestock	
(a) Cattle, drinking only	500 gallons per month per animal
drinking plus sanitation	1,500 gallons per month per animal
(b) Hogs	100 gallons per month per animal
(c) Sheep	100 gallons per month per animal
(d) Chickens	300 gallons per 100 chickens per month
(e) Turkeys	500 gallons per 100 turkeys per month
2. Household	1,500 gallons per person per month
3. Fire Protection	100,000 gallons
4. Irrigation	200,000 gallons per irrigated acre
5. Warmwater fish production	300,000 gallons minimum

Drainage Area

The runoff-producing characteristics of drainage areas are highly variable throughout the province. Soils and land use and relative amounts of rain and snow vary from region to region and from year to year.

In the areas where snow contributes the bulk of seasonal runoff, one acre of hay or pastureland can be depended upon to yield at least 25,000 gallons of runoff water per year. The yield of snowmelt runoff water from plowed land, corn stubble or winter wheatland will be about 15,000 gallons per acre per year.

Runoff from bushland is very unpredictable. Where soils are permeable, much of the water from snowmelt soaks into the ground, resulting in little or no surface runoff. On rough or rocky ground, the water yield will equal or exceed that from cultivated watersheds.

In the Niagara Peninsula and Lake Erie Counties drainage areas will have to be twice as large as those in other areas of the province, to provide an equivalent volume of surface runoff.

Construction of impounding reservoirs on channels draining watersheds of over 100 acres should be avoided wherever possible, unless large volumes of water are required for irrigation purposes. Construction costs for spillways to divert flood waters are normally excessive on large drainage areas. The bypass pond excavated in the flood plain is a good alternative in such situations.

Drainage from barnyards or other sources of pollution should not be permitted to enter the pond at any time.

CONSTRUCTING THE FARM POND

A careful assessment of the factors governing the site selection will be very useful in planning the design and in carrying out the actual construction.

Excavated reservoirs are usually a simple, straightforward undertaking. However, anyone contemplating the construction of a dam should seek the advice of a specialist.

Pond Dimensions

A simple rule for determining reservoir capacity is based on the following relationship:

$$\text{Volume (gallons)} = 100{,}000\ A \times d$$

where A = pond area in acres, and
d = maximum depth of water in feet.

For example, a pond of one-quarter acre in surface area with a maximum depth of ten feet will have a capacity of:

$$\text{Volume} = 100{,}000 \times \tfrac{1}{4} \times 10 = 250{,}000 \text{ gallons.}$$

The depth of water in any pond except in those used for wildlife purposes should not be less than six feet. Where the pond level fluctuates considerably during the season, the depth should be at least ten or twelve feet or sufficient to maintain a depth of at least three feet at the lowest stage.

In general, evaporation and seepage losses will be minimized by constructing the pond of greater depth and reducing the surface area.

The approximate capacities of rectangular excavated ponds are given in the following table:

Pond Storage Capacity

(Size and approximate capacity of rectangular excavated ponds)

Top Dimensions (feet)	Depth (feet)	Capacity (Cubic Yards)	Capacity (Imperial Gallons)
100 x 60	10	980	165,000
	12	990	167.000
120 x 60	10	1,260	213,000
	12	1,330	224,000
150 x 60	10	1,685	284,000
	12	1,800	304,000
120 x 80	10	1,850	312,000
	14	1,985	335,000
140 x 80	10	2,340	394,000
	14	2,550	429,000
160 x 80	10	2,805	472,000
	14	3,090	521,000
140 x 100	10	3,075	518,000
	14	3,400	573,000
180 x 100	10	4,175	704,000
	12	4,600	775,000
	16	5,075	856,000
200 x 100	10	4,875	822,000
	12	5,375	907,000
	16	5,900	995,000
150 x 150	10	5,350	904,000
	12	5,825	982,000
	16	6,470	1,090,000
180 x 150	10	6,750	1,140,000
	12	7,550	1,273,000
	16	8,550	1,443,000
200 x 150	10	7,700	1,300,000
	12	8,630	1,457,000
	16	9,800	1,653,000
200 x 200	10	10,700	1,810,000
	12	12,050	2,030,000
	16	13,950	2,350,000

Excavated Pond Construction

After the selection of the site and determination of storage requirements the top dimensions of the pond can be indicated on the ground by suitable stakes.

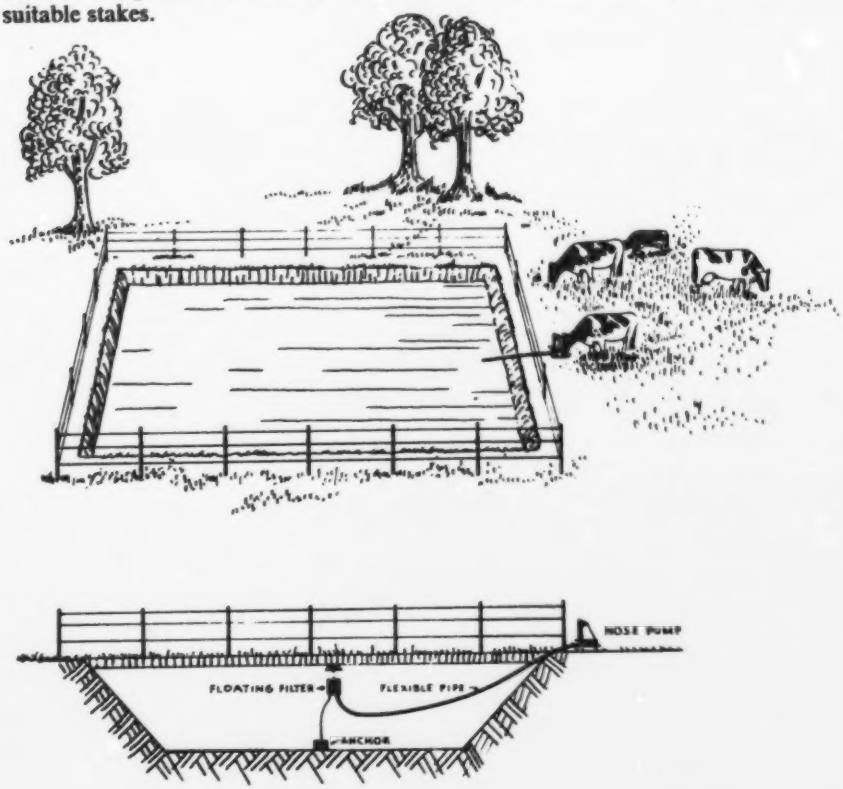

FIGURE 7.
Excavated pond. Industrial earth moving machinery may be used in dry soil and dragline under wet conditions.

Normally, industrial track-type tractors with attached bulldozer blades or hauling wheeled scrapers are most suitable for pond construction work. The first operation in construction will be to strip the topsoil from the region to be excavated and from the area upon which the excavated soil is to be spread. The topsoil should be stockpiled for later use. Excavation and spreading of the soil should then proceed in one continuous operation. The inside slopes of the pond should not be steeper than twelve inches of fall for each twelve inches of horizontal distance. More gentle side slopes are recommended for loam and sandy soils. If the pond is to be

FIGURE 7A.
Wheeled scrapers may be used for pond excavation.

filled above natural ground level, the excavated soil can be used to construct a bank around the pond. The inside slopes of this bank should be no steeper than four inches of rise in each twelve inches of horizontal distance. Spreading the soil in thin layers and compacting thoroughly with the equipment used will reduce the possibility of seepage at ground level, when the pond is filled.

In wet areas, it will be necessary to use a dragline to excavate the soil. Saturated soils tend to be less stable than dry soils, resulting in caving of the banks unless they are gently sloping. Three or four inches of fall per twelve inches of horizontal run are recommended.

Earth cast by the bucket of a dragline will give a rough and untidy appearance to the pond site. It should be spread subsequently and smoothed well back from the pond edges with a bulldozer or similar machine.

After the excavated soil from the pond has been spread and smoothed, the topsoil should be placed over the exposed subsoil. Liberal fertilization and careful seedbed preparation should be followed by seeding of grass at the first favorable opportunity. Irrigation of the seeding will ensure an early establishment of vegetation to protect the pond banks from erosion. Finally, fencing of the pond and provision of water devices for livestock, if required, should complete the pond.

Construction of a Dam

Earth is the most common material used in the construction of a dam for an impounding type of reservoir. Careful planning of the construction

and organization of the various phases is essential in this undertaking. Stock water supply pipes, seepage control devices, facilities for drainage of the pond, spillways for bypassing excess water during and after construction, all are integral parts of the impounding reservoir.

Selecting suitable fill material and great care in its placement are extremely important to ensure the stability of a dam and the prevention of seepage through or underneath the dam.

Normally, a well graded mixture of sand, silt and clay, with twenty percent of silt and clay fractions placed and compacted in a moist condition, will provide an effective barrier to water movement. The barrier should extend below the ground surface as well as above it, and should intersect a natural, impermeable soil layer below the dam foundation.

Procedure for Construction

Preparing the site of the dam and borrow pit. The outline of the base of the dam should be indicated first on the ground by stakes. All materials such as stumps, brush, sod, roots and topsoil should be removed from this site. The soil surface at the dam site should be roughened with corrugations parallel to the main axis of the dam, in order to provide a good bond between the earth fill and the foundation.

All trees should be removed from the flooded area of the pond site prior to filling the reservoir.

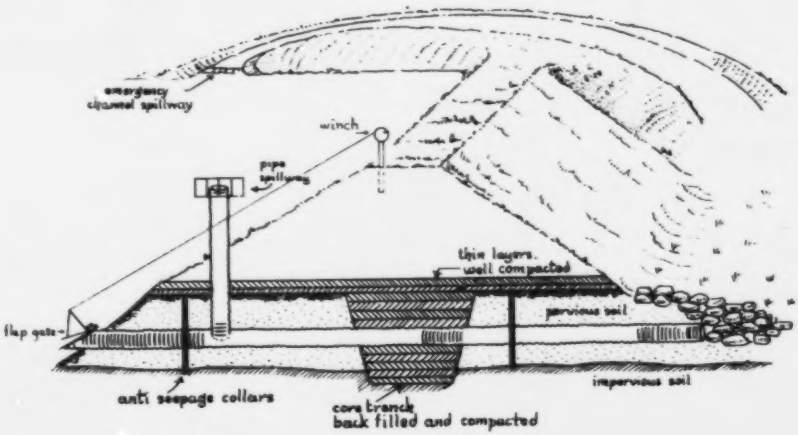

FIGURE 8.

Dam construction details. Alternatives to the spillways illustrated here may be employed, particularly for ponds used for fish. Plans are available from the Agricultural Engineering Extension Specialist of the Ministry of Agriculture and Food.

Construction of the core trench. The core trench is constructed along the main axis of the dam so that a dense, compact wall of soil may be built up from the impermeable subsoil.

The trench should be wide enough for convenient machine excavation and backfilling, and extend the length of the dam from one side of the valley to the other.

Compaction of the soil placed in the core trench is extremely important. Compaction by the wheels or tracks of equipment placing the soil will only be effective along the tracks travelled by the vehicles. Special rollers, or the weighted wheels on tractors, or other devices should be employed to provide compaction over the full width of the trench.

Mechanical spillway. Metal pipes or concrete structures are required to bypass the overflows which may continue for several weeks or months after a major runoff event occurs. The selection of the appropriate pipe size will be based on the local site conditions at the pond. Technical advice on this matter is extremely important.

The pipe spillway consists of a horizontal section of pipe at least six inches in diameter extending from the upstream side of the dam below the natural ground level and projecting beyond the dam on the downstream side. A drain valve or plug on the upstream end is normally required to permit the pond to be drained for repairs, or to control fish or vegetation in the pond.

A vertical riser section of pipe should be welded to the horizontal section or attached by fabricated tee to form a watertight joint. The riser section should extend to the desired water surface level for normal operations. The horizontal section of drain tube should be placed in a trench excavated in undisturbed soil to provide a firm base.

Square anti-seepage collars of steel or concrete of a width at least five times the pipe diameter should be attached to the pipe and a watertight joint assured. Pipe and anti-seepage collars should then be backfilled with moist soil and thoroughly compacted by hand tools around the bottom and sides. Top compaction can be carried out by the wheels of a tractor driven along the direction of the pipe.

Stock watering pipe. If required, a pipe to deliver water from the pond to a watering trough should be installed early in the construction period. The construction of a trench, anti-seepage collars, and backfilling operations will be similar to those required for a mechanical type spillway.

The stock watering pipe should be one and one-quarter inches in diameter with a float control valve at the outlet end. A filter of coarse gravel surrounding a perforated section of pipe contained within a forty-gallon barrel or similar container is required at the inlet end, to prevent trash from entering the pipe.

Floating filters suspended two feet below the surface may be used to collect water from the zone of best quality within the pond.

Emergency spillway. This spillway provides protection for the dam during periods of flood flow. The simplest type consists of a broad channel constructed from the upstream side of the dam around the end of the dam with the outlet end discharging onto a uniform grassy slope.

The elevation of the inlet or upper end of the spillway will normally be one or two feet higher than the top of the pipe spillway, if the latter type is used. If surface runoff water from snowmelt or winter and spring rain is the only water supplying the reservoir, the emergency channel spillway can provide all the protection necessary during periods of flood flow.

The channel spillway should be seeded down or covered with sod and fertilizer at the earliest opportunity, to prevent erosion. Periodic regular fertilization will prevent erosion in subsequent years.

Construction of the embankment. Fill materials should not contain vegetation, large rocks, frozen soil or other foreign substances. Moisture content should be sufficient to secure compaction. When kneaded in the hand, the soil should just form a ball which does not separate readily.

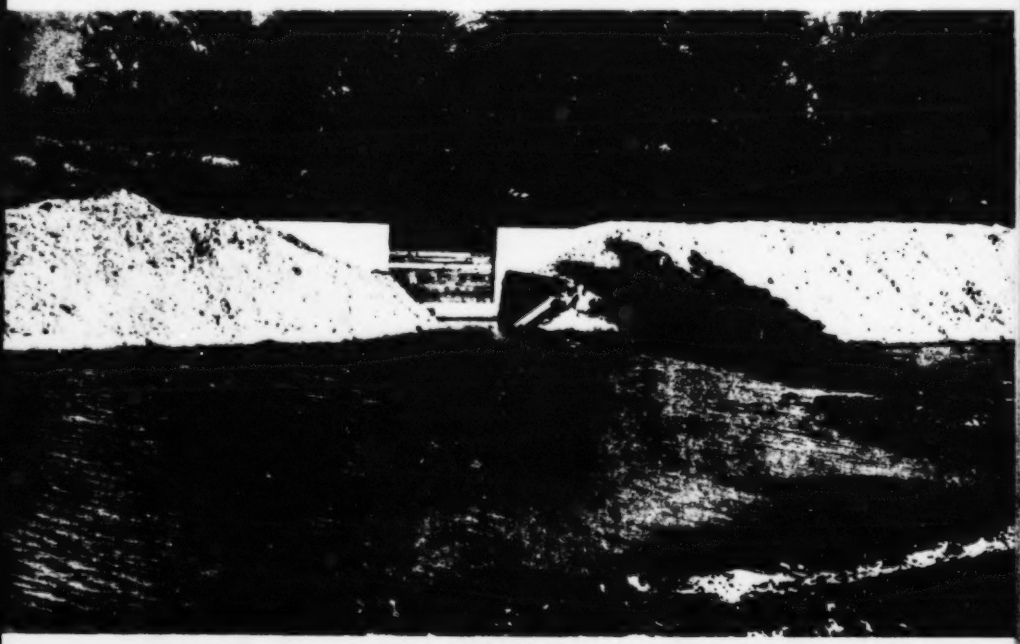

FIGURE 9.
Earth embankment. A concrete spillway is used to pass the flood flows.

Each soil layer of six to twelve inches in thickness, when spread over the full width of the dam, should be compacted by the operation of tractors or other earth-moving equipment or by rolling with a sheepsfoot roller. It may be necessary to apply water to the fill materials by sprinkler or tank truck as each layer is placed in order to obtain sufficient compaction.

Even with compaction the fill will settle in time. It is usual to add an extra ten percent to the height to allow for the settlement.

Slopes. The slopes of the earth fill should be approximately four inches vertical for each twelve inches horizontal run on the upstream side, and six inches vertical for each twelve inches of horizontal run on the downstream side. Flatter slopes will be required on sandier soils which do not tend to stick together.

Portions of slopes not submerged in water should be seeded down to shallow-rooted grasses as soon as possible after the completion of construction. Trees should not be planted on the dam.

Top width of dam. The minimum top width should be eight feet to accommodate the traffic of construction equipment in the finishing phases.

If the top of the dam is to be used as a farm roadway, the top width should not be less than twelve feet.

Fencing. Livestock should not be permitted to drink directly from the pond, or to tramp on either the upstream or downstream slope of a dam. Fencing the site when livestock occupies the pond vicinity will ensure that the pond is maintained in good condition.

MANAGING THE POND FOR FISH PRODUCTION

Ponds to be used for fish production should have certain features which may not be necessary for ponds used for other purposes. However, a good fish pond may be expected to meet most other needs for which farm ponds are constructed.

Trout Ponds

Water supply. Ponds to be used for trout production require a constant supply of cool, clean water. Springs and headwater streams are the most satisfactory source of water. Although ponds built on the lower reaches of streams often may be managed for trout production if the temperature is satisfactory, management may be more difficult because of greater variability and extremes in water conditions, particularly flow, temperature and turbidity. Dugout ponds such as that in Figure 3 are largely dependent upon groundwater but may be managed for trout production in many cases, if properly designed.

FIGURE 10.
A cold-water pond managed for speckled trout fishing by the Metropolitan Toronto Conservation Authority

The surface area of the pond is determined principally by the available water supply and the local topography. An outflow of up to one-half or two cubic feet per second (200 to 800 gallons per minute) per surface acre of pond generally proves to be a satisfactory ratio, although ponds with both lower and higher flows may be good trout waters. If possible, water levels should be kept stable. Ponds should be constructed so that they may be drained totally should reclamation become necessary.

Size of pond. If an appreciable harvest of trout is desired, the pond should have a surface area of at least one-quarter acre. The pond shown in Figure 2 is of a minimum size to provide worthwhile trout fishing. Ponds of one-half to two acres have proven to give the least management problems, although ponds of five to ten acres may be managed to provide excellent fishing.

Ponds with a continuous outflow of water should have an average depth of 6 to 8 feet, with some deeper water. In dugout ponds, or those with a low or intermittent flow, a part of the pond should be at least 12 to 15 feet in depth. The margin of the pond should slope as steeply as possible to a water depth of 3 to 4 feet.

Water temperature. Water temperature is an extremely important factor in the survival and growth of trout. Although trout will survive in water with temperatures ranging from 32°F to over 70°F, the best growth may be expected to occur at temperatures between 50°F and 65°F and some portion of the trout pond should offer water temperatures in this range for best production. Surface water temperatures may safely reach as high as 80°F or more, provided that bottom temperatures do not exceed about 70°F. Because of the geographic location of Ontario, cold water temperatures occurring in ponds from mid-October to late April limit the period of significant trout growth to the summer months.

Choice of species. The native brook or speckled trout, *Salvelinus fontinalis,* has been the most popular species for cold-water ponds. It is produced in quantity in private hatcheries and when kept in trout ponds provides good recreational fishing because of its availability to all forms of angling. It is the most highly colored of available trout species and the flesh is of excellent flavor under usual pond conditions.

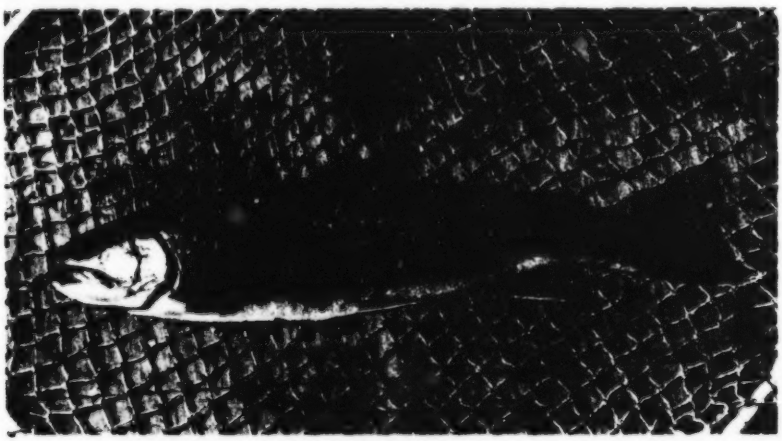

FIGURE 11.
The speckled or brook trout, *Salvelinus fontinalis*

The rainbow or kamloops trout, *Salmo gairdnerii,* which is native to the west coast of North America and has been introduced into eastern waters, is an excellent cold water pond species which is becoming more popular with pond owners because of its ability to thrive in warmer water than the speckled trout. Rainbow and speckled trout may coexist satisfactorily in ponds and owners frequently stock both species. In ponds colder than 65°F both species survive and grow at similar rates but in warmer ponds the environment usually favors the rainbow trout, which gives it a possible advantage over the speckled trout in terms of growth and competition. Rainbow trout are produced commercially in private hatcheries for stocking fishing waters.

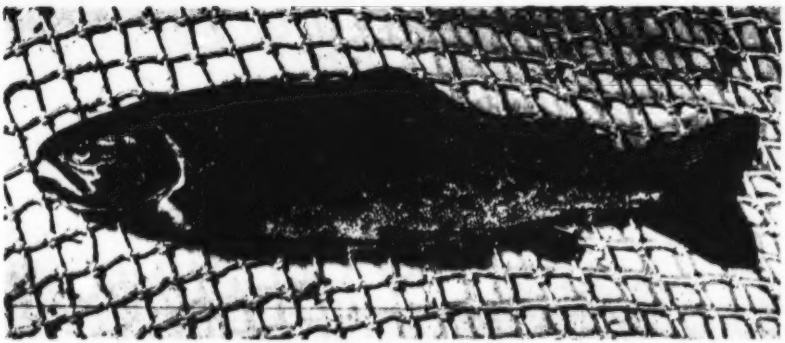

FIGURE 12.
The rainbow or kamloops trout, *Salmo gairdnerii*

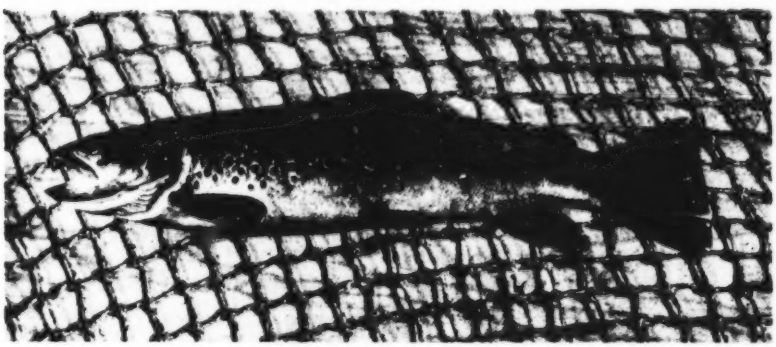

FIGURE 13.
The brown trout, *Salmo trutta*

The brown trout, *salmo trutta,* introduced from Europe many years ago, survives and grows satisfactorily in Ontario ponds and may provide good fishing for the experienced angler. The brown trout tends to be more difficult to catch and may grow to a comparatively large size when it becomes a serious predator on smaller trout of all species. Brown trout are not currently available for purchase in Ontario.

The hybrid splake, a cross between the speckled and lake trout, is another species which adapts itself satisfactorily to the pond environment. However, the splake is not available for purchase and experimental plantings in Ontario ponds indicate no significant advantages over the speckled or rainbow trout to satisfy the extra cost involved in its propagation.

Trout biology. The speckled and rainbow trout require essentially a similar environment for survival, growth and reproduction. They have, also, a similar life history except that the speckled trout is an autumn spawner, while the rainbow trout spawns in either the fall or spring.

High natural mortality rates are characteristic of both speckled and rainbow trout populations, averaging about 80 percent from the fry to the yearling stage. Very few speckled trout live beyond the age of four years. Rainbow trout tend to live longer, a few fish occasionally reaching an age of seven or eight years. The chief causes of natural trout mortality in an otherwise favorable environment include predation by large trout, aquatic mammals and birds, disease and old age.

The growth rates of speckled and rainbow trout in Ontario ponds are dependent primarily on water temperature and available food. In ponds with extremely cold water it is unlikely that many trout of either species will exceed seven or eight inches before dying of old age. In warmer and more productive ponds speckled trout commonly attain lengths of 12 to 15 inches and weights may occasionally reach a pound or more. Rainbow trout may grow to 18 inches or more. It is not uncommon for a few trout, living primarily on smaller fish, to grow abnormally large in a pond, causing

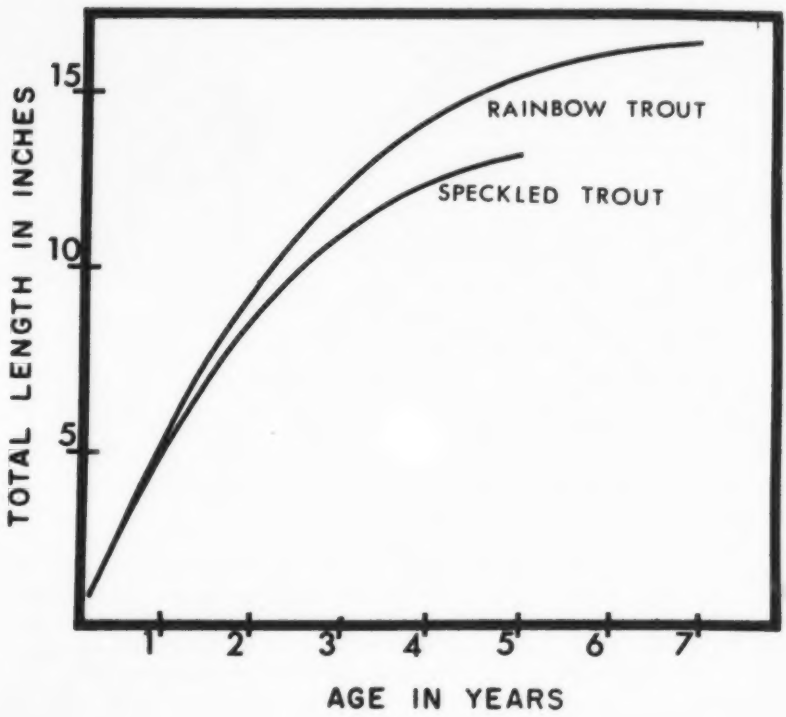

FIGURE 14.
Average growth rates of the speckled and rainbow trout in Ontario farm ponds

a distinct management problem. The capture of large speckled, rainbow and brown trout with weights in excess of four, five and ten pounds respectively are on record for Ontario ponds. These large trout are rarely taken by angling and usually only by experienced fishermen. The average growth rates of speckled and rainbow trout in Ontario ponds are shown in Figure 14.

Male speckled trout in ponds normally mature at age one or two, the females at age two or older. Rainbow trout generally mature a year later than speckled trout. Egg production varies with the size of the female trout, ranging from about 200 to about 2,500 eggs for speckled trout and to over 6,000 for rainbow trout. Speckled trout eggs laid in the autumn normally hatch in two to three months, the exact time depending on water temperature. The eggs of spring spawning rainbow trout hatch after approximately a month of incubation with warming water temperatures. While rainbow trout resident in Ontario waters spawn from February through May, other strains developed through selective breeding elsewhere in North America spawn in virtually all months of the year. At first the newly hatched fish, called fry, live by absorbing nourishment from their yolk sac. Later they feed on microscopic organisms but within a few weeks become dependent on insects, worms, crustaceans, smaller fish and other animal life for food.

The successful natural reproduction of speckled trout and rainbow trout is limited generally to ponds with gravel-bottomed, inflowing, spring-fed streams to which the trout have access during the spawning season. While a suitable stream-pond is usually necessary to maintain a trout population through natural reproduction, some spawning may occur over spring seepage in the pond itself. Successful natural reproduction is unlikely in ponds supplied only by groundwater and surface runoff .

Stocking the pond. Substantial populations of trout in newly constructed ponds may be established by planting fry, fingerling, yearling or older trout. Both speckled and rainbow trout are reared in private commercial hatcheries located in southern Ontario and may be stocked either separately or together in farm ponds, depending on the preference of the pond owner.

Recommended stocking rates for newly constructed ponds or those barren of trout depend on the size of the fish to be planted, the dimensions and fertility of the pond, opportunities for natural reproduction, the desired annual harvest of trout and other factors. The stocking rate recommended for average Ontario ponds expected to provide 100 to 200 hours of recreational angling per year is 1,000 advanced fry (one or two inches in length), or 300 to 500 fingerlings (three to five inches) or 200 to 300 yearlings (six to eight inches) per surface acre of water. Stocking with fry is initially less costly, but mortality is usually greater than with older fish. Trout stocked as yearlings should provide recreational angling during the current fishing season. The stocking of older fish on a put-take basis is an acceptable but expensive practice if immediate angling for larger fish is required.

However, due to the short life expectancy of older trout, this practice does not meet the requirements of most pond owners for sustained angling. Ponds should be stocked with trout of any size only at times when the pond water temperature approximates within a few degrees that of the hatchery from which the trout are procured. The problem of differences in water temperatures can be overcome most simply by restricting plantings to other than the warm summer months.

Maintenance stocking. A restocking program for the pond should be planned carefully to suit the requirements of the particular situation. Ponds managed on a put-take basis generally present less of a management problem than those in which there is natural reproduction of trout, unless sufficient progeny are produced naturally to maintain angling of satisfactory quality. Ponds with good natural reproduction may be expected to provide adequate harvests to meet normal family fishing requirements without supplementation by hatchery-reared fish. However, in ponds with a level of natural reproduction inadequate to meet angling requirements, the establishment of a proper restocking plan is difficult to achieve unless the extent of natural reproduction, standing crop and harvests is determined annually.

Maintenance stockings should be based on a knowledge of the past performance of the fishery, whether or not there is natural reproduction in the pond. While most pond owners are not in a position to place the management of their pond in the hands of a professional fisheries biologist, accurate harvest records should be kept which will indicate trends in fishing quality and serve as a guide for stocking rates. Maintenance stocking is usually, but not necessarily, done in the spring or autumn and either annually or in alternate years. Under conditions of heavy fishing pressure and high harvest levels, stocking on a put-take basis may extend over the fishing season. If predation on newly stocked fish by larger resident trout is to be avoided, it is necessary to plant yearling or older trout. Stocking with trout of this size provides more or less immediate angling. An alternative is to stock larger quantities of fry or fingerling trout with the understanding that a portion of the planting will provide forage for larger resident trout. In most situations there is adequate escapement and survival of young trout to maintain angling of the desired quality.

If based on a knowledge of the past fishing and future angling requirements, maintenance stocking with trout of any size is a satisfactory management procedure.

Fishing the pond. Trout production in ponds can be fully utilized only by an intensive harvest. Fishing ponds should be subjected to a minimum of 100 rod-hours of angling per surface acre each year. For maximum exploitation, the harvest of trout should begin as soon as the fish have reached an acceptable size, probably between five and seven inches, and the objective should be to harvest as many of the trout as possible by the end of their second year of life. In this way, losses because of natural mor-

tality will be held to a minimum. Harvests resulting from an annual angling pressure of 100 to 200 rod-hours per year in trout ponds dependent solely on natural foods have reached 70 pounds per acre in ponds where fishing is maintained only by natural reproduction, and over 300 pounds in ponds where fishing is provided by hatchery-reared trout.

As angling is generally a relatively inefficient method of harvest, it is unlikely that even intensive angling will fully utilize the trout production and other harvest methods should be considered if the full potential of the pond in terms of pounds of flesh is to be realized. The harvest of trout by angling or other methods is subject to the Ontario Fishery Regulations.

Feeding for increased production. Most Ontario ponds are sufficiently fertile to support trout populations established on the basis of recommended stocking rates or maintained by natural reproduction. However, if increased trout production is desired the stocking rates may be increased substantially if artificial foods are used to supplement the natural diet of the trout. Dry rations in pellet form prepared for this purpose are available from farm feed companies. The food may be broadcast on the surface of the pond or may be placed on one or more trays suspended about two feet beneath the surface of the water. Feeding should take place at regular intervals daily or less frequently. The appropriate amount may best be determined by experimentation. The food should be eaten immediately by the trout and should not be allowed to accumulate on the pond bottom, which is evidence of undesirable overfeeding.

The use of forage fish as a source of trout food may be an acceptable practice provided the species chosen does not compete with the trout for habitat or food and is not a potential predator of the trout. Forage species should have a maximum adult size no greater than two to three inches. The introduction of a forage fish should not be attempted except in consultation with a fisheries biologist.

Warmwater Fish Ponds

Water supply. The water supply for warmwater fish ponds may come from several sources. Dugout ponds may be serviced by surface runoff, groundwater, active springs or a combination of these. Stream water may be used by constructing a dam or bypass pond, although water control becomes a problem when the pond is located in the lower part of a watershed.

Ideally, the water supply should be adequate to compensate for seepage and evaporation in order to maintain the water level within the pond. The water should be free of contamination from insecticides, herbicides and other chemical and mechanical pollutants. Where flowing water is used, the inlet and outlet of the pond should be screened to prevent the entry of undesirable fish species.

FIGURE 15.
Pond habitat suitable for largemouth bass

Size of pond. Warmwater fish ponds should not be less than one-quarter acre in surface area. Ponds of two to five acres are generally the most satisfactory to meet normal fishing requirements. Larger ponds are more difficult to manage. The pond should average at least 6 to 8 feet in depth and there should be some area of deeper water, preferably over 12 feet in depth, to lessen the threat of winterkill caused by oxygen depletion.

Water temperature. Ponds in which water temperatures at the bottom exceed 70°F may be managed for warmwater fish production. Because of the relationship between water temperature and fish growth, the growing season for warmwater fish is limited from about early May to late October. Warmwater fish are relatively inactive during the winter months.

Choice of species. The largemouth bass, *Micropterus salmoides,* is the most popular species produced in warmwater ponds. This species may be stocked alone or in combination with forage fish such as the bluegill, golden shiner and fathead minnow. The bluegill provides sport fishing itself and is the species most frequently stocked with largemouth bass in North American ponds. However, research in Ontario has not indicated any significant advantage in terms of bass growth by stocking forage fish, and it is generally satisfactory to stock largemouth bass alone.

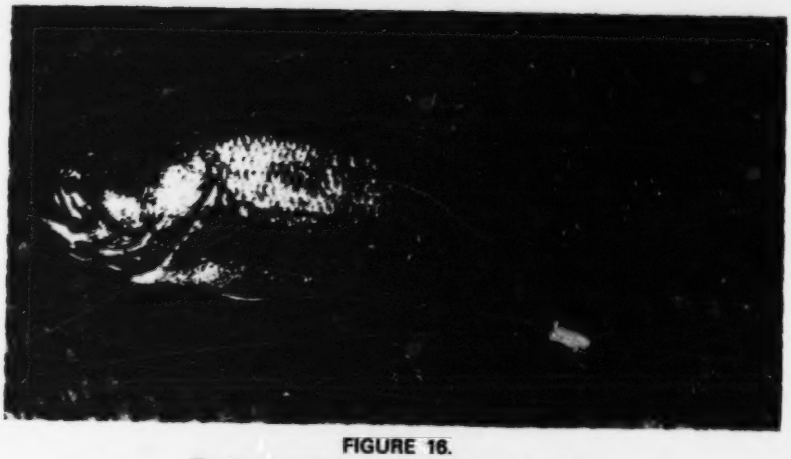

FIGURE 16.
The largemouth bass *Micropterus salmoides*

The use of smallmouth bass, *Micropterus dolomieu,* in Ontario ponds has been more limited than that of the largemouth bass, but its performance in suitable warmwater ponds has proven to be satisfactory.

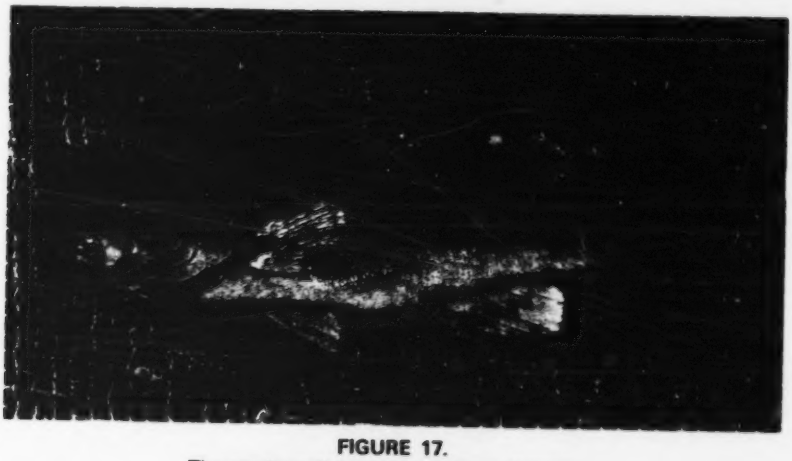

FIGURE 17.
The smallmouth bass, *Micropterus dolomieu*

Various warmwater species, including particularly the bluegill, *Lepomis macrochirus,* other sunfishes, bullheads and perch, have been stocked in some southern Ontario ponds. Angling for these pan fish provides considerable recreation. However, largemouth or smallmouth bass management should not be attempted in combination with the majority of these species.

FIGURE 18.
The bluegill, *Lepomis macrochirus*

Warmwater fish biology. Largemouth bass prefer a weedy environment and require warm water temperatures for growth and reproduction. Common foods of the largemouth bass are aquatic insects, crustaceans, molluscs, frogs and small fish, if present. Under favorable environmental conditions, largemouth bass populations maintain themselves in ponds by natural reproduction. Activity decreases with cooler water temperatures and the largemouth bass spends the winter months in a semi-dormant condition when it ceases to feed or grow appreciably and is difficult to harvest by angling.

The growth of largemouth bass varies greatly among ponds, depending on its population density and the suitability of the environment, particularly in terms of water temperature and available food. The optimum temperature for growth is about 75°F. The average rate of growth for largemouth bass in Ontario ponds is shown in Figure 19.

The largemouth bass matures in Ontario ponds at three or four years of age and at lengths of eight to twelve inches in balanced populations. Mature females produce from 2,000 to 20,000 eggs, depending on the size of the fish. Spawning occurs normally in May or June. A nest is made by the male in shallow water on bottoms of diverse types, often among vegetation. The male bass guards the nest and then the young for about two weeks after hatching.

The life span of largemouth bass in Ontario ponds is about seven years, although few individuals survive beyond five years of age. The natural mortality rate for fry and fingerlings is high but is compensated by the large number of eggs laid by the female. The mortality rate from fingerlings to yearlings and between subsequent years is considerably less. Chief causes of natural mortality include unfavorably cold water temperatures at spawning time, cannibalism and predation by other vertebrates.

The habits and life history of the smallmouth bass are similar to those of the largemouth bass in most respects. It normally thrives under the same environmental conditions if bottom water temperatures do not exceed 80°F and there is not a preponderance of mud bottom and aquatic vegetation. Spawning occurs in June and nests are built preferably on gravel or hard bottom. Maintenance of the population by natural reproduction may be anticipated in suitable ponds.

The bluegill can provide both forage and recreational angling. Its habitat requirements are similar to those of the largemouth bass and successful

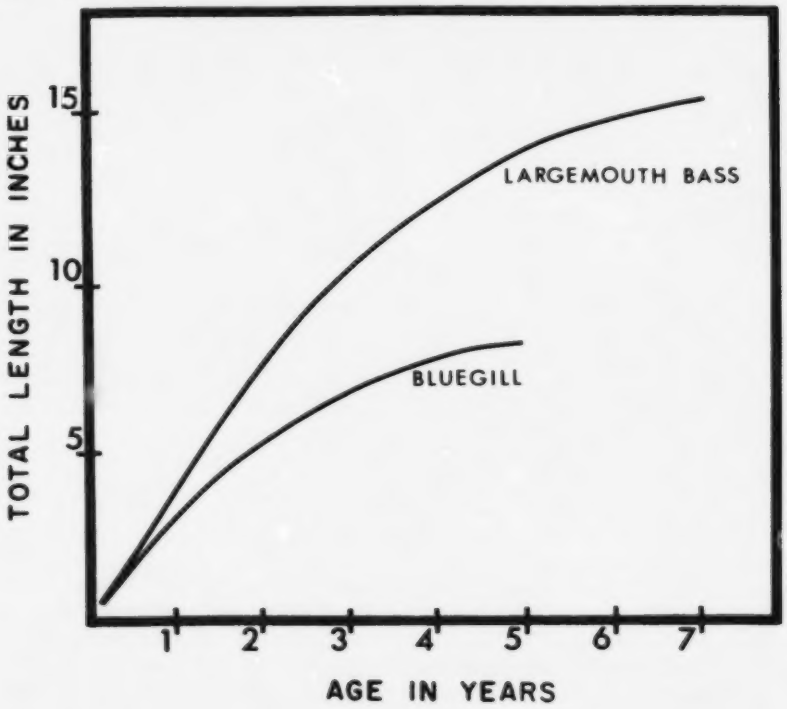

FIGURE 19.
Average growth rates of the largemouth bass and bluegill in Ontario farm ponds

natural reproduction may be expected in most warmwater ponds. The species feeds primarily on aquatic insects and crayfish. It matures in the second year of life in southwestern Ontario. The male constructs the nest and guards the eggs and young fish. The fish grow to four or six inches by the end of the second year and may reach a maximum length of about eight inches by the fifth year. This small size is the chief limitation of the bluegill as a sport fish. The average growth of the bluegill is shown in Figure 19.

Stocking the pond. Fish for stocking warmwater ponds may be purchased from private commercial hatcheries in Ontario or can be obtained and transferred from other waters to the pond, subject to the prior approval of the Ministry of Natural Resources. Care should be taken to avoid temperature changes of more than 5°F when transferring fish from one body of water to another. Fry and fingerlings of bass and bluegills are usually stocked in July and August, yearlings and adults in May and early June.

Stocking rates vary according to the size and condition of the pond. The rate most commonly recommended when largemouth and smallmouth bass are stocked alone is 100 fingerlings (one to three inches), 25 yearlings (five to seven inches) or 10 adults per surface acre of water. Planting of bluegills, if desired, should be with fish of approximately the same age as the bass and at a rate of 1,000 fingerlings (one inch), 50 yearlings (three to five inches) or 25 adults (five to seven inches) per surface acre. There is a good possibility that mixed plantings will become unbalanced and owners are cautioned that pond reclamation to restore fishing quality may be necessary within a few years.

No specific stocking rates are recommended for panfish or coarse fish such as sunfish, perch and bullheads. When adult fish are used on a put-take basis, the number planted should be related to the anticipated harvest in that year. Because of the high reproductive potential of these species, natural reproduction, if it occurs, may be expected to over-populate the pond soon and result in large numbers of stunted fish.

Fishing the pond. A fish population composed only of largemouth or smallmouth bass, or any single species, is the simplest to manage. If parent fish are stocked, angling should be deferred until reproduction occurs with the successful production of progeny. While limited angling for the parent fish may then take place, care should be exercised to leave adequate brood stock for reproduction the next spring. In this way the initial parent stock will provide two-year classes of progeny. If fingerling bass are stocked, the first harvest will be delayed for one or two years, and caution must be observed to avoid over-exploitation of these fish until they have reached maturity and reproduced at least once and preferably twice.

The first appreciable harvest of bass can be made after the first progeny of the original parent stock reach an age of two or three years and an

acceptable size for angling. In each year thereafter a new class should appear in the fishery and the annual harvest of bass may reach 30 pounds per acre, if productive ponds are subjected to adequate angling pressure.

When the bass-bluegill combination is used, the chief management problem is to maintain a proper balance between the two species and there is no guarantee that this objective can be achieved even by intensive angling for the bluegills. All bluegills caught should be kept, regardless of size, after they have had the opportunity to spawn once following introduction into the pond.

Commercial Fish Ponds

Most owners of fish ponds are concerned with management to provide angling and other aquatic recreation or, less often, a source of food for their own use. However, both coldwater and warmwater ponds offer a potential source of revenue for those interested in this feature. Four general opportunities for profit exist: (1) the sale of recreational angling on a variety of plans based usually on a daily or seasonal angling fee, a charge for fish taken or a lease of the pond; (2) the live sale of sport fish reared in the pond, particularly trout and bass, for the stocking of other private waters; (3) the production of fish for sale as food; and (4) the live sale of various species of bait fish for angling. As the sale of trout on the domestic food market has been legalized only recently in Ontario, the economic prospect of this aspect of trout farming has not been established. There is a potential market for bait fish, such as the white sucker and several minnow species which can be produced in farm ponds. Publications dealing specifically with these matters are listed in the Reference Section of this publication.

The commercial use of farm ponds for fish production, angling, or other recreational activities should not be overlooked as one of the potential sources of farm income. However, any major development should be preceded by a cautious investigation from both the economic standpoint and the suitability of the proposed site. Extreme care should be taken to assure proper pond design and management, and it is advisable that the owner seeks professional advice. The Ministry of Natural Resources should be consulted about the legal aspects of commercial fish farming.

MANAGING THE POND FOR WILDLIFE

Virtually all farm ponds will attract a variety of wildlife species. Some live within the pond environment, others inhabit the general locality because of the presence of water. Specific management of the typically small farm pond for wildlife production on an economic basis is rarely justified; nevertheless, development of the pond habitat to favor certain species of wildlife may be expected to increase the utilization of the pond by waterfowl, shorebirds, muskrat, and raccoon in particular.

FIGURE 20.
Wildlife habitat in a farm pond

Unfortunately, the specific development and management of farm ponds for wildlife is not generally compatible with most other purposes, including agricultural uses, requiring an abundance of clean water, fish production and swimming. Some large ponds of five to ten acres, considerably greater than the size of a conventional farm pond, do provide habitat for both fish and wildlife species and serve agricultural and recreational needs. However, most farm ponds if managed specifically for wildlife are environmentally unsuitable for the majority of fish species and harbor species of wildlife, particularly muskrat, raccoon, mink, herons, and kingfishers, which are classed as nuisance animals in fish pond management.

Specific management for wildlife production requires a shallow pond with at least half of the area having a water depth of not more than three feet. Some portion of the pond should be of sufficient depth that it will not freeze to the bottom in the winter, for the survival of muskrat. The pond, if it is to be of value as a habitat for wildlife, must be permitted to grow up with emergent aquatic vegetation over a significant part of the surface area. Without this growth, ducks, other marsh birds and muskrat will find insufficient cover and food.

Some aquatic plants, particularly cattails, may tend to spread too freely, choking out other valuable aquatic plants. Muskrats use cattails extensively for food and in making their houses and their activity will tend to control this plant. Ducks and other marsh birds, while making little direct use of the cattail as food, use it for nesting cover and for the shelter of young birds. Some open water area will make the habitat more favorable for ducks.

Border plantings with shrubs such as dogwood, nannyberry, wild raisin, chokecherry and elderberry offer food in the form of fruit while providing cover. In the wetter areas, high-bush cranberry and black alder are good berry-producing shrubs for wildlife. The balance of the pond periphery may be left in grass, legumes and herbaceous vegetation to provide nesting sites for ducks, pheasants, and other birds. If sufficient area is available, small clumps of conifers will provide good winter shelter for pheasants and rabbits. The pond area may be made more useful for wildlife if it is connected with outlying parts of the farm by shrubbery fencerows which will provide sheltered travel lanes for wildlife moving to and from the pond. The provision of nesting boxes for tree swallows, bluebirds, martins and other birds may encourage the use of the pond environment by these species.

The duck species most commonly found around the farm ponds in Ontario are mallard, black duck and blue-winged teal. Other common species of birds attracted to the pond environment are pheasants, herons, kingfishers, red-winged blackbirds and a variety of shore and song birds. Large mammals include the muskrat, raccoon, and mink. The owner may wish to trap and market the pelts of these furbearers under the authority of a license issued by the Ministry of Natural Resources. Many owners, however, prefer to maintain these and other small mammal species for their aesthetic value only. Deer occasionally frequent more secluded farm ponds.

The key to the usefulness of farm ponds or marshy lowlands for wildlife production lies in the availability of a variety of cover — conifers, shrubs, areas of grass and legumes, aquatic vegetation and limited areas of open water.

PROBLEMS IN POND MANAGEMENT

Procurement of Fish Stocks

A list of private Ontario hatcheries offering live fish for sale may be obtained by writing to the Sport Fisheries Branch of the Ministry of Natural Resources. Species currently produced are the speckled trout, rainbow trout, largemouth bass, smallmouth bass and bluegill. Owners preferring to obtain and transfer brood stock from other waters for use in their own pond should do so only after consultation with the Ministry of Natural Resources.

Fish Kills

Mortalities of fish populations are reported each year by pond owners. Fish kills may be caused by pollution but the most frequent causes are a depletion of dissolved oxygen during the winter, or high summer water temperatures. Disease, except in old age, is an infrequent cause of significant

deaths among sport fishes in farm ponds managed for recreational purposes, but may be a serious problem in rearing ponds or others where fish are held under crowded conditions.

Common pollutants include barnyard drainage and the accidental introduction of agricultural chemicals into the pond. As a cautionary measure, all drainage from the barnyard and from lands exposed to agricultural chemicals should be diverted around the pond. Crop spraying should be carried out when there is no possibility of contamination by wind-borne chemicals.

Oxygen depletion is generally the result of excessive growths of aquatic plants, and occurs principally in late winter when the decomposition of this vegetation underneath a winter ice and snow cover exerts a strong demand on the available supply of oxygen necessary for fish life. Very rarely, fish deaths may occur during the summer in very weedy dugout ponds when respiration exceeds photosynthesis at night, or on calm cloudy days when the dissolved oxygen is reduced to a level which is lethal to fish.

Summer mortalities due to oxygen deficiencies can generally be avoided by controlling the growth of aquatic vegetation and perhaps deepening the pond. Winter oxygen conditions may be made more favorable by the removal of excessive summer growths of weeds prior to the formation of the ice cover, and to some extent by the removal of snow from the ice. Under extreme winter conditions, a small air compressor may be effective in re-aerating the pond water through a perforated hose placed in the pond. Several commercial systems are available for this purpose.

Fish deaths caused by high summer water temperatures are difficult to overcome in ponds lacking an adequate supply of cool water. Mats of rooted aquatic weeds, particularly *Chara,* often provide an insulating layer of cool water at the bottom when the pond is elsewhere thermally unsuitable to specific species of fish. However, good management entails the selection of fish species suited to the temperature conditions provided by the pond. In ponds suspected of being thermally unsuitable, particularly for trout species, it is a good practice to keep a record of surface and bottom summer temperatures.

Fish are less subject to fatal diseases in managed farm ponds, except in old age, than in hatcheries and production ponds where they must exist under crowded and unnatural conditions. In ponds stocked with healthy trout at the recommended rate to provide recreational angling, disease is not a usual problem. However, in the case of any significant mortality of fish in a pond, disease should be suspected as one of the possible causes. Diagnosis of disease and treatment, should disease be present, requires the immediate assistance of a fisheries biologist or pathologist.

Control of Aquatic Vegetation

Excessive growths of aquatic vegetation in ponds present an objectionable appearance, interfere with recreational uses such as fishing, swimming and boating, and agricultural uses, particularly where water is pumped for irrigation and fire protection. At least one species of algae is toxic to cattle.

Fertilizer or barnyard manure carried in water from land adjoining the pond may be the source of nutrients for the aquatic vegetation. Judicious site selection and subsequent watershed management may reduce the magnitude of the problem. However, in spite of these precautions, certain species of aquatic life may invade the pond. Maintenance of the pond depth with a steeply sloping shoreline will tend to limit the spread of the species. If the plants do become established, the pond owner has the choice of either mechanical or chemical treatment, or a combination of both.

Mechanical control methods, while laborious, may be effective and should be considered seriously before undertaking the potentially more dangerous chemical control. Because of the possible adverse effect on the welfare of fish, birds, and mammals if herbicides are improperly used, they must be applied with extreme caution and only under the authority of a permit from the Ministry of the Environment.

For detailed information on the control of aquatic plants, consult the publication *Aquatic Plant and Algae Control* prepared and distributed by the Biology Section, Ministry of the Environment, and the *Guide to Chemical Weed Control,* Publication 75 of the Ministry of Agriculture and Food.

Turbid Water

Although muddy water is seldom lethal to fish species which can otherwise tolerate the available environment, it reduces the aesthetic value of the pond and generally retards biological production. One favorable aspect of turbid water is the control which it exerts on submergent vegetation.

Turbidity in pond water is usually caused by fine clay particles in suspension. Newly constructed ponds and those fed by drainage water from cultivated land are often turbid. The presence of bottom-feeding fish, including suckers, goldfish and carp, can keep ponds in a turbid condition and removal of the offending species may be the only remedy.

Turbid water conditions can usually be improved by bank stabilization, establishment of good land use practices within the watershed, or the diversion of turbid water around the pond. In dugout ponds having clay particles in continuous suspension, the addition of 200 pounds of agricul-

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Control of Aquatic Vegetation

Excessive growths of aquatic vegetation in ponds present an objectionable appearance, interfere with recreational uses such as fishing, swimming and boating, and agricultural uses, particularly where water is pumped for irrigation and fire protection. At least one species of algae is toxic to cattle.

Fertilizer or barnyard manure carried in water from land adjoining the pond may be the source of nutrients for the aquatic vegetation. Judicious site selection and subsequent watershed management may reduce the magnitude of the problem. However, in spite of these precautions, certain species of aquatic life may invade the pond. Maintenance of the pond depth with a steeply sloping shoreline will tend to limit the spread of the species. If the plants do become established, the pond owner has the choice of either mechanical or chemical treatment, or a combination of both.

Mechanical control methods, while laborious, may be effective and should be considered seriously before undertaking the potentially more dangerous chemical control. Because of the possible adverse effect on the welfare of fish, birds, and mammals if herbicides are improperly used, they must be applied with extreme caution and only under the authority of a permit from the Ministry of the Environment.

For detailed information on the control of aquatic plants, consult the publication *Aquatic Plant and Algae Control* prepared and distributed by the Biology Section, Ministry of the Environment, and the *Guide to Chemical Weed Control,* Publication 75 of the Ministry of Agriculture and Food.

Turbid Water

Although muddy water is seldom lethal to fish species which can otherwise tolerate the available environment, it reduces the aesthetic value of the pond and generally retards biological production. One favorable aspect of turbid water is the control which it exerts on submergent vegetation.

Turbidity in pond water is usually caused by fine clay particles in suspension. Newly constructed ponds and those fed by drainage water from cultivated land are often turbid. The presence of bottom-feeding fish, including suckers, goldfish and carp, can keep ponds in a turbid condition and removal of the offending species may be the only remedy.

Turbid water conditions can usually be improved by bank stabilization, establishment of good land use practices within the watershed, or the diversion of turbid water around the pond. In dugout ponds having clay particles in continuous suspension, the addition of 200 pounds of agricul-

tural gypsum or 50 pounds of commercial aluminum sulfate per 100,000 gallons of water is often recommended for turbidity control. The use of organic materials such as hay and green manure for this purpose should be avoided in fish ponds in Ontario since it may contribute to winter oxygen depletion on decomposition.

Control of Undesirable Fish

The presence of undesirable fish is a frequent problem in farm ponds. The problem may concern overpopulation by a preferred species (e.g. largemouth bass or bluegills), the presence of a few large predaceous fish (e.g. trout), or an abundance of coarse fish such as suckers, creek chub and bullheads. The only sound solution is the elimination of the population of undesirable fish, and subsequent restocking with one or more suitable preferred species.

Ponds may be reclaimed by draining, poisoning with a fish toxicant, or a combination of both methods. In most cases it is impossible to eliminate a fish population merely by draining the pond and the use of a fish toxicant is necessary to ensure success. Before a toxicant is used, a permit must be obtained from the Biology Section, Ministry of the Environment.

Rotenone derivatives, locally available at farm supply outlets, are usually recommended at an application rate of two parts per million or one pound per 50,000 gallons of water. Commercial preparations utilizing this compound and other ingredients may be purchased for pond reclamations and should be applied in accordance with the instructions of the manufacturer.

Before any poisoning procedure is undertaken, it is essential that there is an absolute control of the water leaving the pond unless it is certain that there will be no harmful consequences in allowing the treated water to pass downstream. Where possible, the pond should be drained previous to poisoning. This has two advantages: first, the volume of water requiring treatment is considerably less and second, the chemical becomes diluted to a sub-lethal level as the pond refills. Rotenone deteriorates rapidly and the pond will usually be ready for restocking within five or six weeks.

Control of Nuisance Animals

The presence of birds and animals attracted to farm ponds may enhance the aesthetic value. However, the presence of certain animals may become a problem in pond management.

Muskrat and woodchuck. Dam failures are frequently attributed to the burrowing activities of muskrats and occasionally woodchucks. The

pond habitat may be made less attractive for muskrats by the removal of cattails, shrubs, and dense aquatic vegetation. A strip of wire mesh located in the upstream face of the dam above and below the waterline will discourage burrowing. However, trapping is often the only successful means of control and can be done by the owner or by agreement with a licensed trapper.

Beaver. In ponds constructed in flowing water, beaver occasionally present a problem by building a brush dam in the pond spillway. Trapping with live or steel traps is the most satisfactory method of control and preferably should be done by an experienced trapper.

Raccoon and mink. Raccoon and mink are potential predators of fish and may destroy numbers of fish, particularly trout, which are most vulnerable to predation when concentrated around pond inlets or while spawning in tributary streams. At such times, a careful check should be made and control measures taken as required. The pelts of mink, muskrat and beaver, if properly handled by an experienced trapper, can be sold on the fur market, subject to the Game and Fish Act of Ontario.

Water birds. Birds such as the kingfisher and heron frequent farm ponds and may prey on vulnerable fish. The activities of kingfishers may be discouraged by the elimination of perches near the pond; those of heron and other wading birds by maintaining steeply sloping shores.

Fertilization

The fertilization of farm ponds is neither necessary nor desirable in Ontario under most conditions. While the discrete use of fertilizers can create plankton blooms and increase pond productivity, improper or indiscriminate use may be expected to lead to increased growth of rooted aquatic weeds, algae and unattractive pond scums. Agricultural fertilizers should be used only on professional direction.

Seepage Control

Often when care is not taken in the selection of a pond site or in the construction of the dam, water losses occur by seepage through the bottom or sides of the pond. This may be due to permeable soil or insufficient compaction of the earth fill. Careful attention should be given to the construction procedures outlined earlier. Any leakage through an earth embankment should be attended to immediately, to avoid further erosion and the subsequent failure of the structure. The cause of such leaks is frequently poor soil compaction about a pipe or other rigid structure in the fill. Drainage of the pond and repair by tamping clay into the fill at the source of trouble will usually be required.

General seepage through the bed of the pond may often be overcome by adding an impervious blanket of compacted soil. A plastic sheet covered with earth may be used to remedy a seepage problem in smaller ponds. Professional advice should be sought for the best method to overcome specific seepage problems.

FIGURE 21.
Plastic lining may be used to reduce seepage losses.

Erosion Control

Erosion by wave action may occur along the banks of the pond and upstream surface of the dam, causing the water to become turbid and, if severe, may result in damage to the banks or ultimate failure of the dam. A good grass cover on the margins of the pond may be adequate to control shore erosion but it may be necessary to place logs, stones or other objects at water level in situations where erosion cannot be controlled otherwise.

Erosion of the drainage basin and pond margins may result from excess rainfall. Improperly constructed dams may erode on both faces and, if not corrected, can result in collapse of the structure.

The outlet from the mechanical spillway and emergency spillway is particularly vulnerable to erosion due to high water velocities. The discharge from a pipe spillway should drop into a stilling pool protected by flat stones on the bottom, the sides, and on the embankment where the pipe projects. The water should then flow downstream after overflowing the pond.

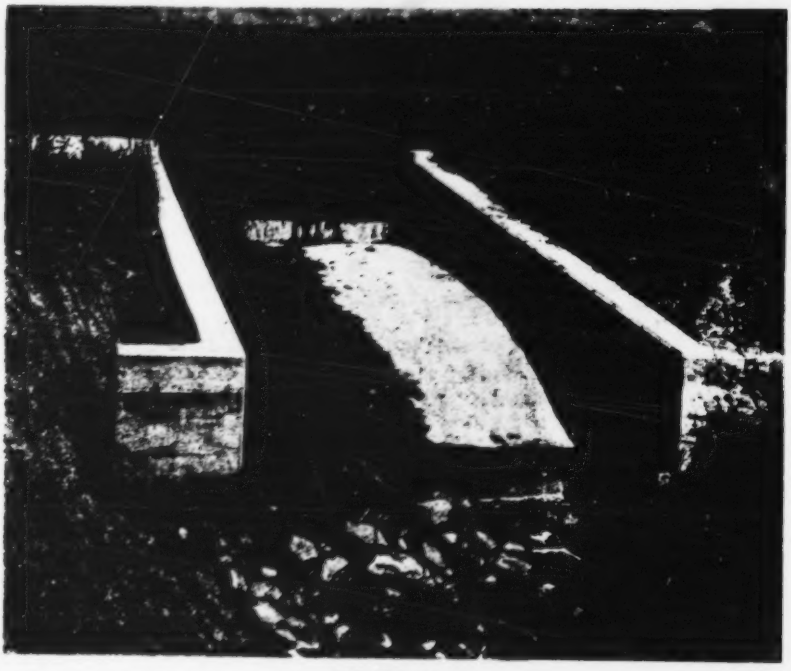

FIGURE 22.
Spillway erosion should be checked immediately to prevent serious damage.

The flow from the emergency spillway should form a uniform sheet of water on the slope on which it discharges. Every effort should be made to ensure that the water does not concentrate in a narrow channel. Repairs should be effected as soon as erosion is noticed, by sodding the damaged areas after filling any gullies.

LEGAL ASPECTS OF FARM PONDS

It is the responsibility of pond owners to be familiar with all legislation dealing with the use of water, pond construction, pond management, techniques and the utilization of fish and wildlife produced. The following information on pertinent legislation will be of particular interest to farm pond owners.

Public Liability

Fencing is recommended to keep livestock out of a pond. Also for the safety of children it is advisable to have a good fence constructed around the pond. However, neither fencing nor posting against trespass absolves the owner of liability in case of accident.

Water Use, Including Pumping, Dams and Diversions

The regulations regarding the taking, diversion and storage of water for purposes other than domestic, farm (not including irrigation) and fire fighting are stated in the Ontario Water Resources Act. The Act states that no person shall take more than 10,000 gallons per day by any means — including diversion and storage in a pond — without a permit issued by the Ministry of the Environment, Water and Well Management Section, Water Quantity Branch.

Dam Construction

Approval for the construction of dams on streams must be obtained from the Minister of Natural Resources. The requirements for such construction are outlined in the Lakes and Rivers Improvement Act.

Procurement and Sale of Fish

Regulations made under the Game and Fish Act govern the procurement and sale of game fish raised in private waters. One license authorizes live sale of game fish for the purpose of stocking fishing waters. The other license allows the sale of trout for human consumption. Pond owners contemplating the purchase or disposal of fish stocks should consult the legislation. The pond owner may, without the authority of a license, charge an access fee to fishermen for the privilege of angling in a farm pond.

Harvest of Fish by Angling

The harvest of fish from Ontario farm ponds by angling is subject to the Ontario Fishery Regulations which establish fishing seasons and creel limits.

Use of Herbicides, Pesticides, and Fish Poisons

Under the Ontario Water Resources Act, a permit is required before any substance may be added to a pond for the control of aquatic plants or animals. This legislation does not apply to ponds with no outlet and wholly confined within the owner's property. Application for the permit should be made to the Biology Section, Ministry of the Environment, P.O. Box 213, Rexdale, or by contacting any District Office of the Ministry of Natural Resources.

Control of Nuisance Mammals and Birds

Mammals causing damage to ponds may be controlled under the authority of the Game and Fish Act of Ontario, which permits their destruction at any time and by any means. Where fur-bearing animals are involved, the pond owner should notify the local Conservation Officer or the District Forester of the Ministry of Natural Resources. Under the Migratory Birds Convention Act and the Game and Fish Act of Ontario, all water birds, including kingfishers, herons, ducks, eagles, and ospreys, are protected. It is not legal to destroy these species.

Harvest of Wildlife Species

Under the Game and Fish Act, a farmer or any of his sons residing upon his lands may without a license hunt or trap thereon fur-bearing animals during their open season, and may hunt thereon birds or animals with the exception of certain big game species during the open season. Also, the farmer or any of his sons may, without a license, sell the fur-bearing animals or pelts thereof, provided a record is kept and returns are made to and as specified by the Ministry of Natural Resources. Pond owners may make arrangements with trappers licensed under the Ontario Game and Fish Act for the harvest of furbearers.

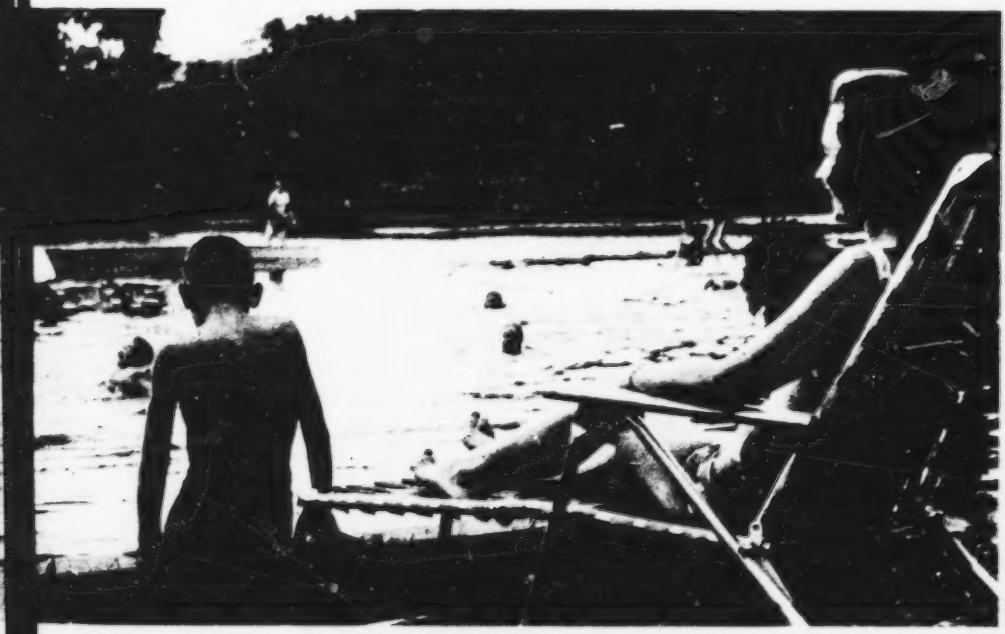

FIGURE 23.
Recreation provided by a multipurpose farm pond.

Although this Act makes no specific provisions regarding construction and management of ponds, it does enable river valley Conservation Authorities to undertake certain programs respecting land use and water management. The farm pond program has been an important activity on the part of several authorities for many years. There may be certain requirements to be satisfied when constructing a pond, to satisfy the general program of land and water conservation being carried forward by the authority.

Technical and Financial Assistance

Technical advice, and information regarding financial assistance or special local regulations may be obtained by contacting the Agricultural Engineering Specialist at the County Agricultural Representative's Office of the Ministry of Agriculture and Food.

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